IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Application No.:	09/697,570
Applicants:	Shinya MATSUDA, Takashi MATSUO, and Masayuki UEYAMA
For:	ACTUATOR USING DISPLACEMENT ELEMENT
Confirmation No.:	4859
Customer No.:	24367
Docket No.:	15162/02660
Filed:	October 26, 2000
Group Art Unit:	2834
Examiner:	Cuevas, Pedro J.

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August 5, 2003
Date of Deposit

Brian E. Harris
Name of Applicant, Assignee, or Registered Representative

Signature

August 5, 2003
Date of Signature

MS APPEAL BRIEF- PATENTS
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

BRIEF ON APPEAL

Real Party in Interest

The real party in interest in the present Application is Minolta Co., Ltd., a corporation of Japan, having an office at Osaka Kokusai Building, 3-13, 2-Chome, Azuchi-Machi, Chuo-Ku, Osaka-Shi, Osaka, Japan 541-8556.

Related Appeals and Interferences

There are no related appeals or declared interferences which will directly affect or be directly affected by the present Application to the knowledge of the undersigned.

Status of Claims

Claims 1-12 are the subject of this appeal. No other claims are pending. No claims have been added or canceled during the pendency of the present application.

Status of Amendments

No amendments were filed by Appellant in response to the Office Action of December 9, 2002.

Summary of Invention

The present invention relates to an actuator having a displacement element or elements, such as piezoelectric elements, for driving a driven member. An example of this type of actuator is shown in Fig. 3. In this example, the actuator is for rotating a rotor 40. The actuator comprises a pair of laminate-type piezoelectric elements 10 and 10'. Each of the piezoelectric elements 10 and 10' is connected at one end to a tip member 20. Each of the piezoelectric elements 10 is connected at another end to a base 30.

A driver, shown in Fig. 4, is for driving the piezoelectric elements 10 to cause the tip member 20 to travel in an elliptical (including circular) path. The drive circuit includes a phase controller 51 that can vary a phase difference between signals applied to the piezoelectric elements 10. The drive circuit also includes an amplitude controller 53 that can vary the amplitude of the signals to the piezoelectric elements 10. Figs. 5a-5e show how the path of the tip member 20 varies based on the phase difference produced by the drive circuit. Figs. 6a-6f show how the path of the tip member 20 varies based on the amplitude of the signal produced by the drive circuit.

As shown in Figs. 17a-e, the actuator can drive the rotor 40 by using the tip member 20 to push against a surface of the rotor 40 as the tip member is driven along its elliptical path. The rotor 40 can be driven by the tip member 20 in this manner in one of two states, an intermittent contact state and a normal contact state. In the intermittent contact state, the tip member 20 travels along a path that includes a period of temporary separation from the rotor 40 (Specification, page 2, lines 6-14). This is the state illustrated in Figs. 17a-e. However, when the amount of displacement of the piezoelectric members 10 and 10' is very small, such that the amount of displacement of the tip member 20 is less than several micrometers, the elasticity of the rotor 40 and the tip member 20 combined with the very small path of the tip member 20 results in the normal contact state (Specification, page 3, lines 1-6).

According to the present invention, an actuator is provided that includes a compression member. An embodiment is shown in Fig. 10, where a spring 41 serves as the compression member. The spring 41 exerts a pressing force to cause the tip member 20 and the rotor 40 to be near a state of transition between the intermittent contact state and the normal contact state (Specification, page 11, lines 6-9 and page 13, lines 8-13). The reason for this flows from data shown in Figs. 7-9.

Fig. 7 shows data for the contact interval versus compression force of the spring 41 for different voltage levels. Fig. 8 shows data for the velocity of the tip member 20 versus load force due to contact between the tip member 20 and the rotor 40 when the driving voltage is 50 volts for a variety of compression forces in Fig. 7 of the spring 41. Fig. 9 is similar to Fig. 8, except the vertical scale represents drive efficiency. From the data shown in Figs. 8 and 9, it was appreciated that a desirable degree of drive efficiency could be combined with a desirable amount of drive force when the spring 41 applies a compression force in a region between 2-3 N, preferably near 2.5 N. Fig. 7 shows that, for the voltage level of 50 volts used to acquire the data in Figs. 8 and 9, a compression force of the spring 41 corresponds with a position near the transition between the intermittent contact state (contact interval < 1) and the normal contact state (contact interval ~ 1).

An analysis is described in the Specification on pages 13-17 with reference to Figs. 10-12 for deriving a more general expression of a relationship between the properties of the parts of the actuator system that would allow for the tip member 20 and the rotor 40 to be near a state of transition between the intermittent contact state and the normal contact state. Fig. 10 shows how the actuator of the present invention was modeled for the analysis, which is diagramed in Figs. 12a-d.

In this analysis, k1 and m1 represent the spring constant and mass, respectively, of the spring 41; k2 and m2 represent the spring constant and mass, respectively, of the piezoelectric members 10 and 10' combined with that of the tip member 20; and k3 and m3 represent the spring constant and mass, respectively, of the rotor 40. Fig. 12a shows an initial state of the system; Fig. 12b shows the affect of a force N generated by the integration of the system but without the application of a drive voltage; Fig. 12c shows the affect of a force N' generated when a drive voltage is gradually increased to the piezoelectric members 10 and 10'; and Fig. 12d shows the affect of a force N" as the voltage to the piezoelectric members 10 and 10' is rapidly decreased.

Based on the models in Figs. 10 and 12, a relationship for each of the forces N, N', and N" was derived based on Hooke's Law:

$$N = \Delta X1 \times k1 = \Delta X2 \times k2 = \Delta X3 \times k3$$
$$N' = \Delta X1' \times k1 = (X0 - \Delta X2') \times k2 = \Delta X3' \times k3$$
$$N'' = \Delta X2'' \times k2 = \Delta X3'' \times k3$$

From these relationships, equations (2) and (3) of the present specification were derived:

$$N - N' = -X0 / (1/k1 + 1/k2 + 1/k3) \qquad (2)$$
$$N' - N'' = X0 / (1/k2 + 1/k3) \qquad (3)$$

(It is noted that Equation 2 shown on page 16 of the specification, as can be appreciated by the discussion and equations thereabove, includes an error wherein a negative sign was

inadvertently omitted.) From equations (2) and (3), an expression was derived where N' is eliminated:

$$N-N'' = X0(1/(1/k2 + 1/k3) - 1/(1/k1 + 1/k2 + 1/k3))$$

(It is noted that the above equation as shown on page 16, line 15 of the specification, as can be appreciated by the discussion and equations thereabove, includes an error wherein N' is shown instead of N".) As seen in Figs. 12a-12d, N" is representative of a force that does not include any influence by the spring 41, and N is representative of a force when the system is complete but not under the influence of a voltage. Thus, by setting N"=0, Equation (4) was derived for a force, designated Nt, which is a critical compression force of the spring 41 at the time of transition from the intermittent driving state to the normal contact state (Specification, page 16, lines 16-19):

$$Nt = X0(1/(1/k2 + 1/k3) - 1/(1/k1 + 1/k2 + 1/k3)) \qquad (4)$$

Thus, a system can be realized where the tip member 20 and the rotor 40 are driven near the point of transition between intermittent and normal contact based on the compressive force of the spring 41.

Issue

Whether claims 1-12 are patentable under 35 U.S.C. § 103(a) over U.S. Patent No. 5,696,421 to Zumeris et al. ("Zumeris") in view of U.S. Patent No. 6,201,340 B to Matsuda et al. ("Matsuda").

Grouping of Claims

With respect to the sole issue on appeal, in order to make the appeal process as efficient as possible and for the purpose of this appeal only, Appellants agree to have the claims of the sole issue considered in a single group.

Argument

Issue — Whether claims 1-12 are patentable under 35 U.S.C. § 103(a) over U.S. Patent No. 5,696,421 to Zumeris et al. ("Zumeris") in view of U.S. Patent No. 6,201,340 B to Matsuda et al. ("Matsuda").

Of claims 1-12, dependent claims 2-6 depend, directly or indirectly, from independent claim 1, and dependent claims 8-12 depend, directly or indirectly, from independent claim 7.

Each of independent claims 1 and 7 is directed to an actuator comprising a displacement element (claim 1) or first and second displacement elements (claim 7), a drive member, a stationary member, a compression member, and a drive circuit. With respect to the compression member, each of claims 1 and 7 recites in part:

> a compression member for pressing said drive member against the driven member such that the drive member and the driven member are in a state of intermittent contact, and under conditions near a condition of transition from the intermittent contact state to a normal contact state

It is conceded in the Office Action dated December 9, 2002 ("Office Action") that Zumeris fails to teach a compression member as required by the present claims (*see* Office Action, section 2, para. 3). So, the Office Action relies on Matsuda for the claimed compression member, alleging that "Matsuda et al. teaches the construction of a compression member ([chip member] 20) for pressing said driven member against the drive member ..." (Office Action, section 2, para. 4, lines 1-2). However, this allegation is respectfully traversed as follows.

For one, the chip member 20 disclosed in Matsuda is not a compression member. The chip member 20 is described in Matsuda as follows:

> A chip member **20** is fixed on contacting faces at top ends of the first and the second piezoelectric devices **10** and **10'** positioned at crossing point thereof by an adhesive. Contacting faces at base ends of the first and the second piezoelectric devices **10** and **10'** are fixed on an base member **30** by the adhesive. When the first piezoelectric device **10** and the second

> piezoelectric device **10'** are respectively driven by the AC driving signals having the phase difference of 90 degrees, the chip member **20** can be moved for trailing an ellipse or a circle. The first piezoelectric device **10** and the second piezoelectric device **10'** are substantially the same as the piezoelectric device **10** shown in FIG. 1, the elements of the second piezoelectric device **10'** are distinguished from those of the first piezoelectric device **10** by adding a dash (') to the numerals.
>
> When *the chip member **20** is pushed, for example, on a cylindrical surface of a rotor **40*** which can be rotated around a predetermined shaft, it is possible *to convert the elliptic or the circular movement of the chip member **20** to the rotation of the rotor **40*** (Matsuda, col. 3, lines 44-63).

Thus, Matsuda discloses that chip member 20 "is pushed ...on ...a surface of a rotor" by piezoelectric devices. This is contrary to the compression member recited in the present claims, which is "for pressing said drive member against the driven member". That is, Matsuda does <u>not</u> disclose that the chip member 20 is *for pressing a drive member against a driven member*. The chip member 20 does not press anything against the rotor 40. Instead, the chip member 20 is, itself, pressed against the rotor 40. Therefore, the chip member 20 disclosed by Matsuda cannot be considered equivalent to the claimed compression member.

In addition, the claims require that the compression member press a drive member against a driven member "under conditions near a condition of transition from the intermittent contact state to a normal contact state." Matsuda does not disclose that the chip member 20 and the rotor 40 are driven near such a transition point. In fact, Matsuda does not even address the normal contact state, but only discloses intermittent contact between the chip member 20 and the rotor 40 (*see* Matsuda, col. 7, lines 57-60).

So, since each of Zumeris and Matsuda fails to disclose the claimed compression member, the proposed combination of Zumeris and Matsuda would likewise fail to disclose the claimed compression member. Therefore, the proposed combination of Zumeris and Matsuda fails to render the present claims obvious.

Conclusion

In view of the foregoing, a *prima facie* case of obviousness has not been established with regard to claims 1-12. Accordingly, Appellants respectfully request the Board of Patent Appeals and Interferences to reverse the Examiner's rejections as to all of the appealed claims.

Respectfully submitted,

By: ______________________
Brian E. Harris
Registration No. 48,383
Agent for Appellant

BEH:bar
SIDLEY AUSTIN BROWN & WOOD LLP
717 N. Harwood, Suite 3400
Dallas, Texas 75201
(214) 981-3461 (Direct)
(214) 981-3300 (Main)
(214) 981-3400 (Facsimile)
August 5, 2003

Appendix A
(37 C.F.R. § 1.192(c)(9))

1. (Previously Presented) An actuator for moving a driven member, said actuator comprising:

a displacement element for producing a specific displacement;

a drive member connected to one end of said displacement element and which transfers the displacement of said displacement element to a driven member;

a stationary member which supports the other end of the displacement element;

a compression member for pressing said drive member against the driven member such that the drive member and the driven member are in a state of intermittent contact, and under conditions near a condition of transition from the intermittent contact state to a normal contact state; and

a drive circuit for driving said displacement element.

2. (Previously Presented) An actuator as claimed in claim 1, wherein a following relationship is satisfied:

$Nt=X0(1/(1/k2+1/k3)-1/(1/k1+1/k2+1/k3))$

when a spring constant of the compression member is designated k1, a combined spring constant of the displacement element and the drive member is designated k2, a spring constant of the driven member is designated k3, an amount of displacement of the displacement element is designated X0, and a compression force applied by the compression member is designated Nt.

3. (Original) An actuator as claimed in claim 2, wherein said drive circuit drives said displacement element at a resonance frequency.

4. (Original) An actuator as claimed in claim 1, wherein said drive circuit drives said displacement element at a resonance frequency.

5. (Previously Presented) An actuator as claimed in claim 1, wherein said displacement element is a laminate type piezoelectric element.

6. (Previously Presented) An actuator as claimed in claim 5, wherein said displacement element includes alternating layers of a plurality of piezoelectric thin plates and electrodes.

7. (Previously Presented) An actuator for moving a driven member, said actuator comprising:

a first displacement element for producing a first specific displacement;

a second displacement element for producing a second specific displacement having a direction which has a predetermined angle to a direction of the first specific direction of said first displacement element;

a drive member connected to one end of each of said first and second displacement elements and which transfers the displacement of said first and second displacement elements to a driven member;

a stationary member which supports the other end of each of the first and second displacement elements;

a compression member for pressing said drive member against the driven member such that the drive member and the driven member are in a state of intermittent contact, and under conditions near a condition of transition from the intermittent contact state to a normal contact state; and

a drive circuit for driving said first and second displacement elements.

8. (Previously Presented) An actuator as claimed in claim 7, wherein a following relationship is satisfied:

$Nt=X0(1/(1/k2+1/k3)-1/(1/k1+1/k2+1/k3))$

when a spring constant of the compression member is designated k1, a combined spring constant of the first and second displacement elements and the drive member is designated k2, a spring constant of the driven member is designated k3, an amount of displacement of the first and second displacement elements is designated X0, and a compression force applied by the compression member is designated Nt.

9. (Original) An actuator as claimed in claim 8, wherein said drive circuit drives said first and second displacement elements at a resonance frequency.

10. (Original) An actuator as claimed in claim 7, wherein said drive circuit drives said first and second displacement elements at a resonance frequency.

11. (Previously Presented) An actuator as claimed in claim 7, wherein each of said first and second displacement elements is a laminate-type piezoelectric element.

12. (Previously Presented) An actuator as claimed in claim 11, wherein each of said first and second displacement elements includes alternating layers of a plurality of piezoelectric thin plates and electrodes.

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MS APPEAL BRIEF- PATENTS
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BRIEF ON APPEAL

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Summary of Invention

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A driver, shown in Fig. 4, is for driving the piezoelectric elements 10 to cause the tip member 20 to travel in an elliptical (including circular) path. The drive circuit includes a phase controller 51 that can vary a phase difference between signals applied to the piezoelectric elements 10. The drive circuit also includes an amplitude controller 53 that can vary the amplitude of the signals to the piezoelectric elements 10. Figs. 5a-5e show how the path of the tip member 20 varies based on the phase difference produced by the drive circuit. Figs. 6a-6f show how the path of the tip member 20 varies based on the amplitude of the signal produced by the drive circuit.

As shown in Figs. 17a-e, the actuator can drive the rotor 40 by using the tip member 20 to push against a surface of the rotor 40 as the tip member is driven along its elliptical path. The rotor 40 can be driven by the tip member 20 in this manner in one of two states, an intermittent contact state and a normal contact state. In the intermittent contact state, the tip member 20 travels along a path that includes a period of temporary separation from the rotor 40 (Specification, page 2, lines 6-14). This is the state illustrated in Figs. 17a-e. However, when the amount of displacement of the piezoelectric members 10 and 10' is very small, such that the amount of displacement of the tip member 20 is less than several micrometers, the elasticity of the rotor 40 and the tip member 20 combined with the very small path of the tip member 20 results in the normal contact state (Specification, page 3, lines 1-6).

According to the present invention, an actuator is provided that includes a compression member. An embodiment is shown in Fig. 10, where a spring 41 serves as the compression member. The spring 41 exerts a pressing force to cause the tip member 20 and the rotor 40 to be near a state of transition between the intermittent contact state and the normal contact state (Specification, page 11, lines 6-9 and page 13, lines 8-13). The reason for this flows from data shown in Figs. 7-9.

Fig. 7 shows data for the contact interval versus compression force of the spring 41 for different voltage levels. Fig. 8 shows data for the velocity of the tip member 20 versus load force due to contact between the tip member 20 and the rotor 40 when the driving voltage is 50 volts for a variety of compression forces in Fig. 7 of the spring 41. Fig. 9 is similar to Fig. 8, except the vertical scale represents drive efficiency. From the data shown in Figs. 8 and 9, it was appreciated that a desirable degree of drive efficiency could be combined with a desirable amount of drive force when the spring 41 applies a compression force in a region between 2-3 N, preferably near 2.5 N. Fig. 7 shows that, for the voltage level of 50 volts used to acquire the data in Figs. 8 and 9, a compression force of the spring 41 corresponds with a position near the transition between the intermittent contact state (contact interval < 1) and the normal contact state (contact interval ~ 1).

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In this analysis, k1 and m1 represent the spring constant and mass, respectively, of the spring 41; k2 and m2 represent the spring constant and mass, respectively, of the piezoelectric members 10 and 10' combined with that of the tip member 20; and k3 and m3 represent the spring constant and mass, respectively, of the rotor 40. Fig. 12a shows an initial state of the system; Fig. 12b shows the affect of a force N generated by the integration of the system but without the application of a drive voltage; Fig. 12c shows the affect of a force N' generated when a drive voltage is gradually increased to the piezoelectric members 10 and 10'; and Fig. 12d shows the affect of a force N" as the voltage to the piezoelectric members 10 and 10' is rapidly decreased.

Based on the models in Figs. 10 and 12, a relationship for each of the forces N, N', and N" was derived based on Hooke's Law:

$$N = \Delta X1 \times k1 = \Delta X2 \times k2 = \Delta X3 \times k3$$
$$N' = \Delta X1' \times k1 = (X0 - \Delta X2') \times k2 = \Delta X3' \times k3$$
$$N'' = \Delta X2'' \times k2 = \Delta X3'' \times k3$$

From these relationships, equations (2) and (3) of the present specification were derived:

$$N - N' = -X0 / (1/k1 + 1/k2 + 1/k3) \qquad (2)$$
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(It is noted that Equation 2 shown on page 16 of the specification, as can be appreciated by the discussion and equations thereabove, includes an error wherein a negative sign was

inadvertently omitted.) From equations (2) and (3), an expression was derived where N' is eliminated:

$$N\text{-}N'' = X0(1/(1/k2 + 1/k3) - 1/(1/k1 + 1/k2 + 1/k3))$$

(It is noted that the above equation as shown on page 16, line 15 of the specification, as can be appreciated by the discussion and equations thereabove, includes an error wherein N' is shown instead of N".) As seen in Figs. 12a-12d, N" is representative of a force that does not include any influence by the spring 41, and N is representative of a force when the system is complete but not under the influence of a voltage. Thus, by setting N"=0, Equation (4) was derived for a force, designated Nt, which is a critical compression force of the spring 41 at the time of transition from the intermittent driving state to the normal contact state (Specification, page 16, lines 16-19):

$$Nt = X0(1/(1/k2 + 1/k3) - 1/(1/k1 + 1/k2 + 1/k3)) \qquad (4)$$

Thus, a system can be realized where the tip member 20 and the rotor 40 are driven near the point of transition between intermittent and normal contact based on the compressive force of the spring 41.

Issue

Whether claims 1-12 are patentable under 35 U.S.C. § 103(a) over U.S. Patent No. 5,696,421 to Zumeris et al. ("Zumeris") in view of U.S. Patent No. 6,201,340 B to Matsuda et al. ("Matsuda").

Grouping of Claims

With respect to the sole issue on appeal, in order to make the appeal process as efficient as possible and for the purpose of this appeal only, Appellants agree to have the claims of the sole issue considered in a single group.

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Each of independent claims 1 and 7 is directed to an actuator comprising a displacement element (claim 1) or first and second displacement elements (claim 7), a drive member, a stationary member, a compression member, and a drive circuit. With respect to the compression member, each of claims 1 and 7 recites in part:

> a compression member for pressing said drive member against the driven member such that the drive member and the driven member are in a state of intermittent contact, and under conditions near a condition of transition from the intermittent contact state to a normal contact state

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> A chip member **20** is fixed on contacting faces at top ends of the first and the second piezoelectric devices **10** and **10'** positioned at crossing point thereof by an adhesive. Contacting faces at base ends of the first and the second piezoelectric devices **10** and **10'** are fixed on an base member **30** by the adhesive. When the first piezoelectric device **10** and the second

> piezoelectric device **10'** are respectively driven by the AC driving signals having the phase difference of 90 degrees, the chip member **20** can be moved for trailing an ellipse or a circle. The first piezoelectric device **10** and the second piezoelectric device **10'** are substantially the same as the piezoelectric device **10** shown in FIG. 1, the elements of the second piezoelectric device **10'** are distinguished from those of the first piezoelectric device **10** by adding a dash (') to the numerals.
>
> When *the chip member **20** is pushed, for example, on a cylindrical surface of a rotor **40*** which can be rotated around a predetermined shaft, it is possible *to convert the elliptic or the circular movement of the chip member **20** to the rotation of the rotor **40*** (Matsuda, col. 3, lines 44-63).

Thus, Matsuda discloses that chip member 20 "is pushed ...on ...a surface of a rotor" by piezoelectric devices. This is contrary to the compression member recited in the present claims, which is "for pressing said drive member against the driven member". That is, Matsuda does <u>not</u> disclose that the chip member 20 is *for pressing a drive member against a driven member*. The chip member 20 does not press anything against the rotor 40. Instead, the chip member 20 is, itself, pressed against the rotor 40. Therefore, the chip member 20 disclosed by Matsuda cannot be considered equivalent to the claimed compression member.

In addition, the claims require that the compression member press a drive member against a driven member "under conditions near a condition of transition from the intermittent contact state to a normal contact state." Matsuda does not disclose that the chip member 20 and the rotor 40 are driven near such a transition point. In fact, Matsuda does not even address the normal contact state, but only discloses intermittent contact between the chip member 20 and the rotor 40 (*see* Matsuda, col. 7, lines 57-60).

So, since each of Zumeris and Matsuda fails to disclose the claimed compression member, the proposed combination of Zumeris and Matsuda would likewise fail to disclose the claimed compression member. Therefore, the proposed combination of Zumeris and Matsuda fails to render the present claims obvious.

Conclusion

In view of the foregoing, a *prima facie* case of obviousness has not been established with regard to claims 1-12. Accordingly, Appellants respectfully request the Board of Patent Appeals and Interferences to reverse the Examiner's rejections as to all of the appealed claims.

Respectfully submitted,

By: ______________________

Brian E. Harris
Registration No. 48,383
Agent for Appellant

BEH:bar
SIDLEY AUSTIN BROWN & WOOD LLP
717 N. Harwood, Suite 3400
Dallas, Texas 75201
(214) 981-3461 (Direct)
(214) 981-3300 (Main)
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Appendix A
(37 C.F.R. § 1.192(c)(9))

1. (Previously Presented) An actuator for moving a driven member, said actuator comprising:

a displacement element for producing a specific displacement;

a drive member connected to one end of said displacement element and which transfers the displacement of said displacement element to a driven member;

a stationary member which supports the other end of the displacement element;

a compression member for pressing said drive member against the driven member such that the drive member and the driven member are in a state of intermittent contact, and under conditions near a condition of transition from the intermittent contact state to a normal contact state; and

a drive circuit for driving said displacement element.

2. (Previously Presented) An actuator as claimed in claim 1, wherein a following relationship is satisfied:

$Nt=X0(1/(1/k2+1/k3)-1/(1/k1+1/k2+1/k3))$

when a spring constant of the compression member is designated k1, a combined spring constant of the displacement element and the drive member is designated k2, a spring constant of the driven member is designated k3, an amount of displacement of the displacement element is designated X0, and a compression force applied by the compression member is designated Nt.

3. (Original) An actuator as claimed in claim 2, wherein said drive circuit drives said displacement element at a resonance frequency.

4. (Original) An actuator as claimed in claim 1, wherein said drive circuit drives said displacement element at a resonance frequency.

5. (Previously Presented) An actuator as claimed in claim 1, wherein said displacement element is a laminate type piezoelectric element.

6. (Previously Presented) An actuator as claimed in claim 5, wherein said displacement element includes alternating layers of a plurality of piezoelectric thin plates and electrodes.

7. (Previously Presented) An actuator for moving a driven member, said actuator comprising:

a first displacement element for producing a first specific displacement;

a second displacement element for producing a second specific displacement having a direction which has a predetermined angle to a direction of the first specific direction of said first displacement element;

a drive member connected to one end of each of said first and second displacement elements and which transfers the displacement of said first and second displacement elements to a driven member;

a stationary member which supports the other end of each of the first and second displacement elements;

a compression member for pressing said drive member against the driven member such that the drive member and the driven member are in a state of intermittent contact, and under conditions near a condition of transition from the intermittent contact state to a normal contact state; and

a drive circuit for driving said first and second displacement elements.

8. (Previously Presented) An actuator as claimed in claim 7, wherein a following relationship is satisfied:

$Nt=X0(1/(1/k2+1/k3)-1/(1/k1+1/k2+1/k3))$

when a spring constant of the compression member is designated k1, a combined spring constant of the first and second displacement elements and the drive member is designated k2, a spring constant of the driven member is designated k3, an amount of displacement of the first and second displacement elements is designated X0, and a compression force applied by the compression member is designated Nt.

9. (Original) An actuator as claimed in claim 8, wherein said drive circuit drives said first and second displacement elements at a resonance frequency.

10. (Original) An actuator as claimed in claim 7, wherein said drive circuit drives said first and second displacement elements at a resonance frequency.

11. (Previously Presented) An actuator as claimed in claim 7, wherein each of said first and second displacement elements is a laminate-type piezoelectric element.

12. (Previously Presented) An actuator as claimed in claim 11, wherein each of said first and second displacement elements includes alternating layers of a plurality of piezoelectric thin plates and electrodes.

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